Section 2.5

Utilities and Services

Contents

Contents

Contents

Item	Page Number

FIGURES

Contents

Item **Page Number**

TABLES

Section 2.5
Utilities and Services

2.5.1. Compressed Air System

2.5.1.1. Purpose

The Compressed Air System provides a continuous supply of compressed air for the instrument air system, process vessels in the pretreatment building, process building, and other miscellaneous users.

2.5.1.2. Description

The compressed air system consists of the following:

a. Inlet filters
b. Compressors
c. Receivers
d. Air dryers
e. Distribution system

At the normal load, the proposed TWRS-P Compressed Air System will have two centrifugal compressors running with the third compressor cycling depending on the load. The fourth compressor will be on standby. The compressors feed two air receivers. The air is then dried by cooling in two refrigerated air dryers. Only one process air dryer is required for normal flowrates, the additional dryer will be on standby or out-of-service for maintenance. The air is dried to protect instrumentation from water condensation within the piping system that will cause maintenance problems. The compressors are oil free machines and the air is effectively oil free (< 1ppm) under normal conditions. The air to the compressors is taken from a clean location to keep it free from corrosive contaminants and hazardous gases, which might be drawn into the compressor intake. Figure 2.5-1 shows the compressed air makeup system.

Air pressure is monitored and alarmed.

The air distribution system is divided into main systems: (1) the critical air users, and (2) the non-critical air users. Critical users include the following systems which would be comprised or damaged on loss of air:

- Instrument air system
- Process/equipment that requires the use of 10 barg compressed air
- Melter support systems

Non-critical air users include all other systems. For this discussion, only the Instrument Air System is designated as an Important to Safety (ITS) SSC.

2.5.1.3. Instrument Air System

The Instrument Air System is connected to the Compressed Air System (CAS) downstream of the dryers. The compressed air is passed through a filter, a twin tower desiccant dryer, and an after-filter. An instrument air receiver is located downstream of the dryer after-filter and serves to dampen pressure variations. Downstream of the instrument air receiver, the air is split into two distribution paths, one is for Important to Safety (ITS) users and the other is for non-ITS users. The ITS instrument air users are supplied in each building by ring headers that are connected to bottled backup air racks at strategic locations on the ring headers. The main air header is isolated from the non-ITS air users and the Compressed Air System by a check valve. The check valve is open as long as the Compressed Air System supply pressure is greater than the ITS air supply header pressure. The isolation check valve prevents air from the backup bottled air supply racks, connected to the ITS instrument air header, from flowing to the non-ITS header when the Compressed Air System is not supporting the instrument air system demand.

The backup bottled air supplies are equipped with pressure control instrumentation and pressure regulating valves to maintain the air pressure slightly below the normal header pressure. If the CAS maintains the required instrument air pressure, the pressure regulation valves remain closed and bottled air is not consumed. If the Compressed Air System is unable to supply the instrument air demand, the pressure regulators downstream of the bottled air supplies will open to maintain their set pressure. Reduction of bottled air pressure is alarmed. Figure 2.5-2 shows the instrument air system.

2.5.1.4. Hazardous Situations

The hazards associated with the Instrument Air System are:

- Loss of Instrument Air either by loss of supply or rupture of line leading to the loss of air to ITS instruments.

The set of Important to Safety SSCs for the above hazardous situation (or fault) is provided in the following table. The table also identifies the safety function and the Design Safety Features.

Figure 2.5-1. Compressed Air

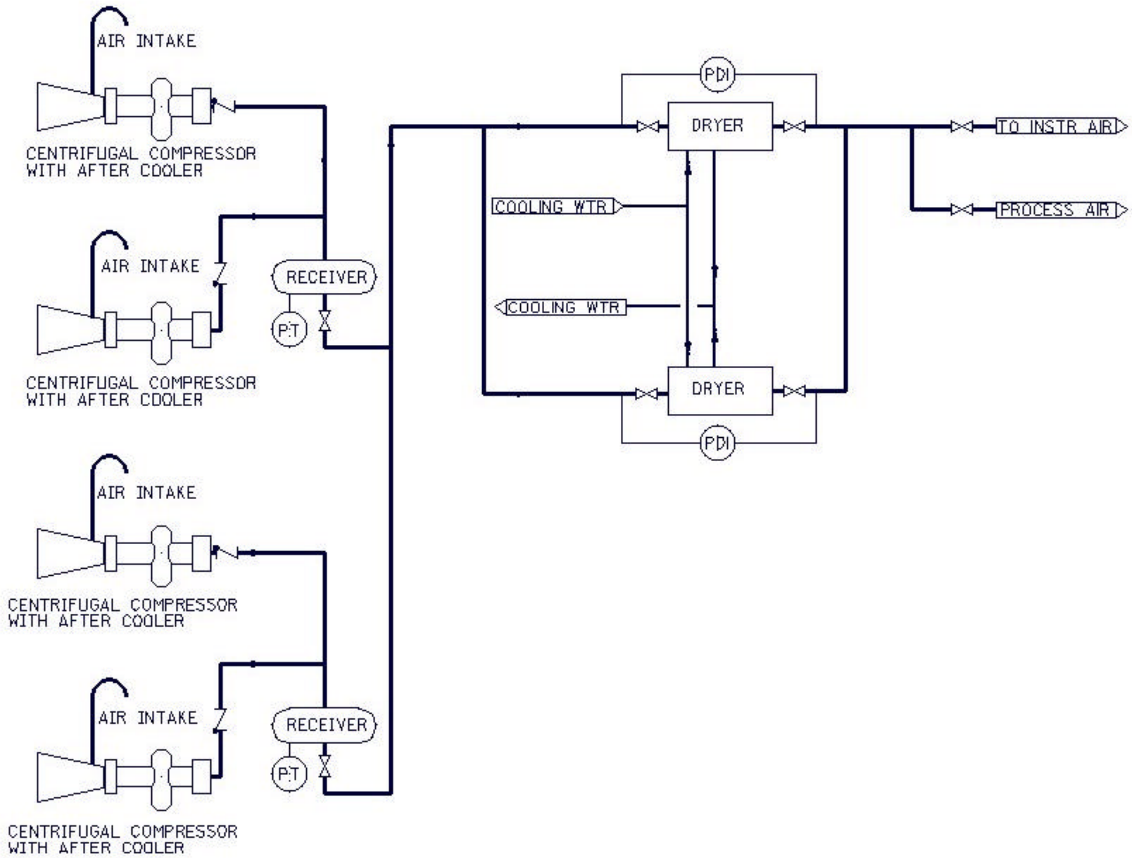


Figure 2.5-2. Instrument Air

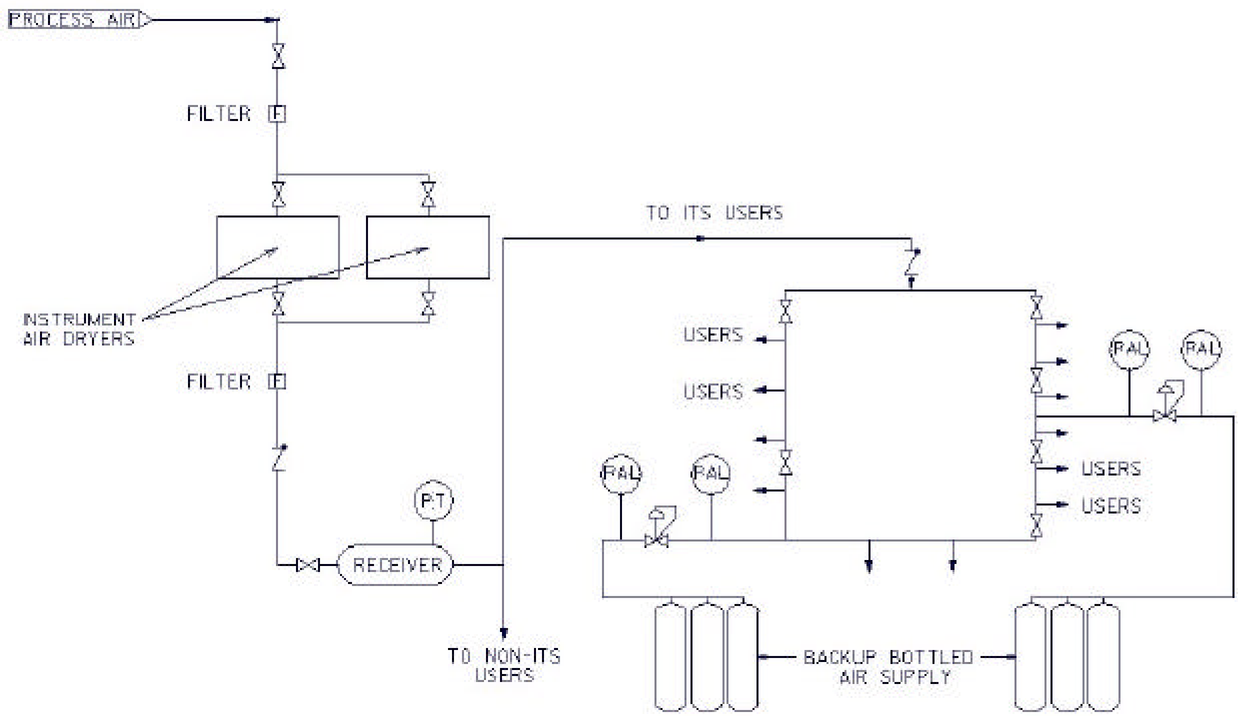


Table 2.5-1. Instrument Air System

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Loss of Compressed Air System leading to loss of air to ITS instruments	Backup compressed air bottles connected to the ITS Instrument Air headers	Provide alternate source of instrument air to ITS users long enough to complete a safe shutdown.	Backup compressed air supply pressure is monitored and alarmed before pressure is reduced to a minimum acceptable pressure.
	Backup air supply pressure regulation controls and valves	Connect backup supply to the ITS instrument air users if significant reduction in header pressure	Functionality of the backup air supply pressure control system is tested periodically to identify failures of the control system. Header and backup air supply low pressure instrumentation are trouble alarms
	Isolation Check Valve	Conserve bottled air supply by isolating non ITS instrument air users from ITS instrument air users	Functionality of the backup air supply pressure control system is tested periodically to identify failures of the control system.
Break in ITS air distribution piping.	Ring or looped ITS air supply header with isolation valves spaced around the loop.	Backup for possible main failure due to corrosion or physical impact	The use of a ring or looped ITS air supply header in each building is a passive feature of the facility design. The isolation valves are manually operated.

2.5.2. Cooling Water Systems

2.5.2.1. Purpose

Cooling water is applied to vessels to control the temperature within the vessel since some vessel contents are heat generating, particularly in the case of high level wastes (HLW). The normal methods of applying cooling to a vessel are to employ cooling coils within the vessel or a jacket to the outside of the vessel. Cooling water is also used to cool vapor streams within ventilation system condensers and within coaxial pipe heat exchangers.

Cooling water is supplied from a centralized cooling water plant which services the entire facility.

2.5.2.2. Description

The technetium concentrate storage tank (stores both technetium and cesium) and the technetium and cesium ion exchanger will be water cooled. In some instances, the liquid may be self-boiling. To provide the necessary cooling, the vessel may be fitted with an external cooling jacket or internal cooling coils. Cooling water is passed through the jacket or coils to control the temperature within the vessel. For shell and tube condensers, the cooling water is passed through the tubes.

The cooling water systems comprise two circuits. One circuit provides the cooling of the vessel or condenser and passes into the cell and equipment within welded pipe. Several circuits may be served by a common header. The second circuit provides cooling of the primary circuit via a plate heat exchanger. This circuit is located out of cell and is connected to the main plant cooling tower.

Design of cooling water systems typically protects the system against long-term corrosion and/or organic fouling through procedural measures, which detail the monitoring regime required to ensure the appropriate water quality within the secondary cooling water circuit, and the provision of biocide addition. A demineralized water head tank, with monitoring and suitable buffering, will be used to provide a treated and constant demineralized water supply to the primary cooling circuit. Cooling water used within the secondary cooling water circuits would be supplied from a treated and constant water source to minimize variations in quality.

The integrity of the cooling water system is ensured through the functional testing of the cooling water circuit instrumentation. A typical example of this is the testing of a gamma radiation detection monitor to confirm that the detector is capable of gamma radiation detection and calibrated correctly. Testing also requires the confirmation of both DCS software alarm action and hardwired trip action as appropriate to that device.

The operability and performance of the active system are ensured through commissioning of the cooling water system, which includes QA checks followed by functional testing. The overall operability of the system, including the applicable portions of the protection systems and transfer between normal and emergency power sources, will be demonstrated during normal operation. This will be ensured through routine functional testing of the safety features within the system and the functionality of the associated instrumentation (i.e., administrative controls and maintenance activities).

Consideration will be given to providing suitable cooling water system redundancy by: (1) using spare equipment, powered from a separate supply as necessary, (2) from alternative water supplies in the event of an abnormal operation or failure and, (3) the use of both DCS software alarms and hardwired interlocks on instrumentation. Figure 2.5-3 is a schematic representing a typical cooling water system.

2.5.2.3. Hazardous Situations

The hazards associated with the cooling water system are:

1. Breakthrough of activity into the cooling circuit from the failure of the cooling coil or tube resulting in increased dose to facility workers.

   Normal practice at BNFL Sellafield is to provide redundancy in the vessel cooling systems in the event of a cooling system leak. In the case of jacketed vessels, this is provided by means of partitioning the jacket such that there are at least two separate circuits running around the vessel. Only one circuit needs to operate to provide sufficient cooling capacity. In the case of cooling coils, the redundancy is provided by having separate circuits of coils with each circuit being able to provide sufficient cooling capacity. Leak detection is provided through the application of a gamma monitor. Isolation of the contaminated cooling water is by valves and delay tanks, where appropriate.

2. Loss of Cooling Water to ITS Systems

   In the event of a cooling water supply failure, a process water supply connection is installed to allow process water to pass through the vessel cooling circuit to provide some measure of cooling. In the case of self-boiling liquids, a process water supply is normally provided to the vessel to prevent the liquid boiling dry.

   The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the safety function and the Design Safety Features.

Figure 2.5-3. Cooling Water System

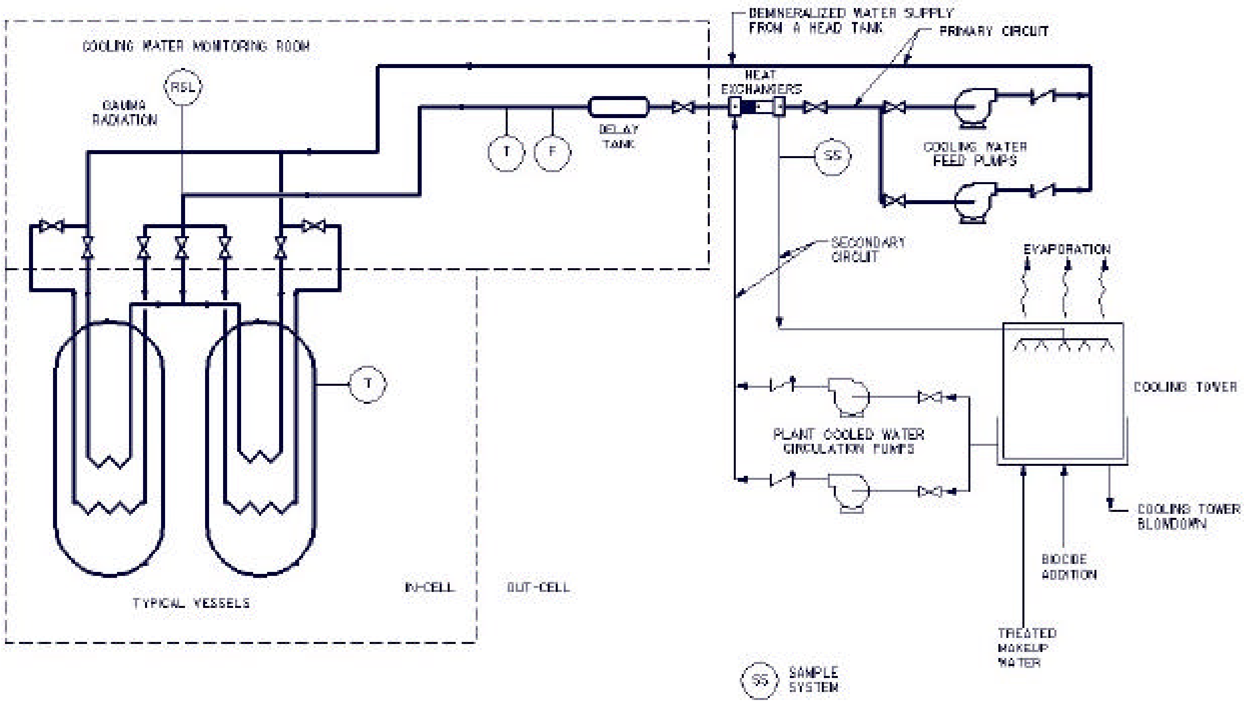


Table 2.5-2. Cooling Water Systems

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Breach of the cooling water system integrity causing activity to pass into the cooling circuit	Cooling water coil pipework or cooler tubes	To maintain integrity for all postulated process operating conditions (e.g., fluid composition of vessel and operating ranges and cycles of temperatures.	In-cell pipework integrity See Section 2.1.2, Piping
	Gamma detection monitor	To provide alarm and action to isolate cooling water circuit on detection of activity within the circuit.	Functional test trouble alarm redundant
	Isolation valves	To isolate cooling water circuit	Fail-safe
	Delay Tank	To provide sufficient time for detection and isolation of active material within the shielded area.	Tank or pipework is designed to provide sufficient hold up at the maximum postulated cooling water recirculation rate
	Area Radiation Monitors	To indicate above background radiation levels and alarm	Battery-backed Trouble alarm
	Cooling water head tank	To provide a higher pressure in the cooling water circuit than in the vessel in the event of pinhole leaks but not major failures of coil.	Filling of head tank on low level alarm.
	Water quality	Water quality is maintained for optimum corrosion protection	Demineralized water used for water circuit is sampled periodically

Table 2.5-2. Cooling Water Systems

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Loss of Cooling water to ITS cooling systems	Pump	To provide required cooling water flow and temperature	Redundant pump provided. Normal separate trains electrical power
	Piping	Delivers cooling water to the system.	Valves fail safe (open), In-cell pipe integrity.
	Flow and Temperature monitoring	Indicates the operation of cooling duties outside the normal operating conditions and the potential onset of inadequate cooling	Instruments trouble alarmed Diverse measurements
	Cooling Coil or tubes	Provide liquid Cooling	Redundant coil providing as a minimum equal cooling as the primary coil.
			Defense in depth in the case of boiling tank: Mitigation of releases provided by the presence of scrubber and HEMEs in the vessel ventilation system.

2.5.3. Demineralized Water Supply

2.5.3.1. Purpose

Demineralized water is supplied to the TWRS-P facility processes for cold chemical feed preparation, plant washing, steam generation, water scrubbing and quenching. Demineralized water is chosen for these duties to prevent the contamination or blockage of plant operations through the use of lower quality water. This water is free from dissolved salts, minerals and organic matter that could cause corrosion and scaling of pipes and fittings.

2.5.3.2. Description

Demineralized water will be supplied and distributed to the various plant users from a demineralizer unit. The demineralized water is fed through one or more break tanks to prevent any backflow of contamination to the various user locations at the plant. The number of break tanks for the plant is determined by the frequency and volume use of water. The break tanks will connect into a ring main if serving a number of users. All supply lines would be taken off the bottom of the ring main. The user will be supplied through contained isolation valves (see Plant Wash) or valved entry into a process feed tank. Transfers into the active environment will be via a valve and loop seal.

2.5.3.3. Hazardous Situations

The identification of the potential hazardous situations resulting from the unavailability of demineralized water to the various process users has not yet been addressed in detail. At this time, the demineralized water supply system is not considered ITS. The hazardous situations listed below are potential hazards that could be expected during the operation of the demineralized water system.

1. Back contamination of water supply giving rise to the potential dose to plant workers

2. Overfilling of in-cell vessel leading to the movement of active material out of the in-cell shielded area. Overfilling protection is addressed under shielding and confinement (i.e., loss of confinement due to overfilling vessel).

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Figure 2.5-4. Demineralized Water to In-Cell

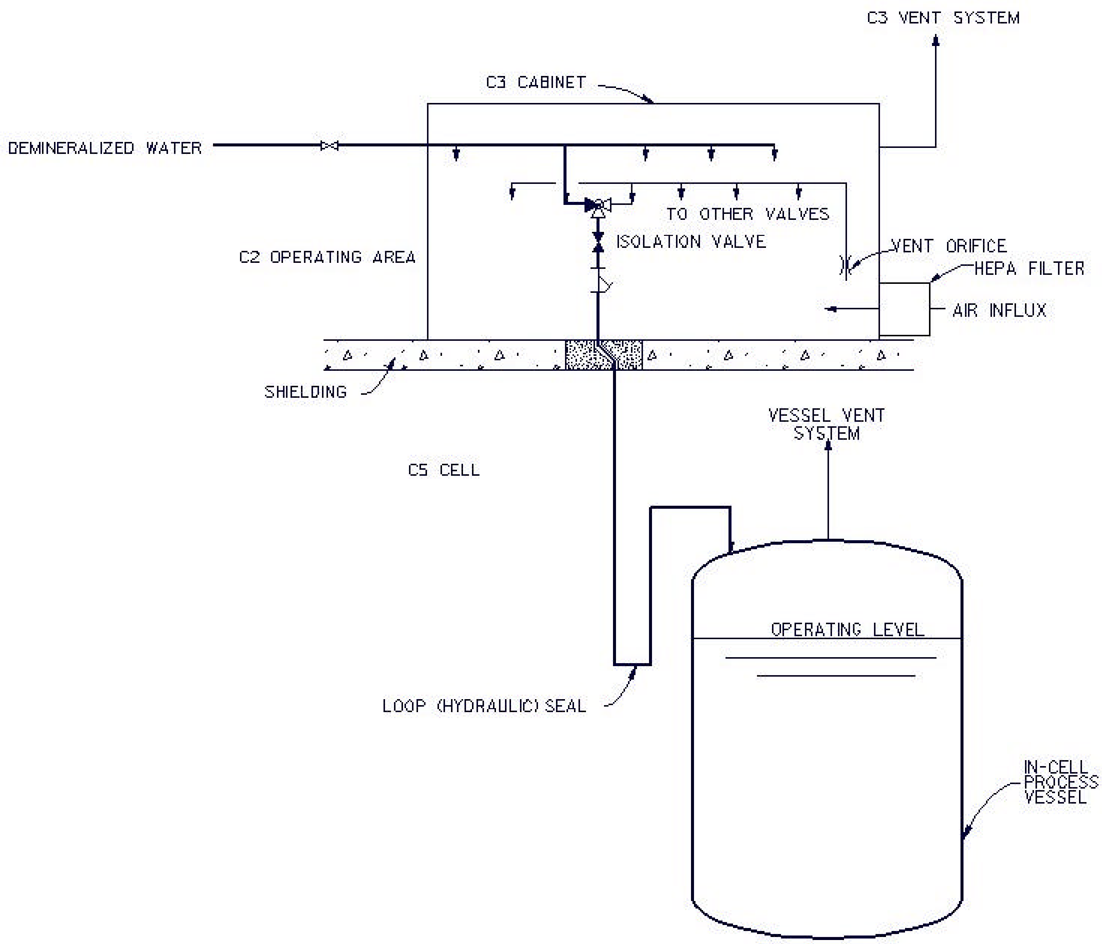


Figure 2.5-5. Demineralized Water to In-Cell Through Breakpot

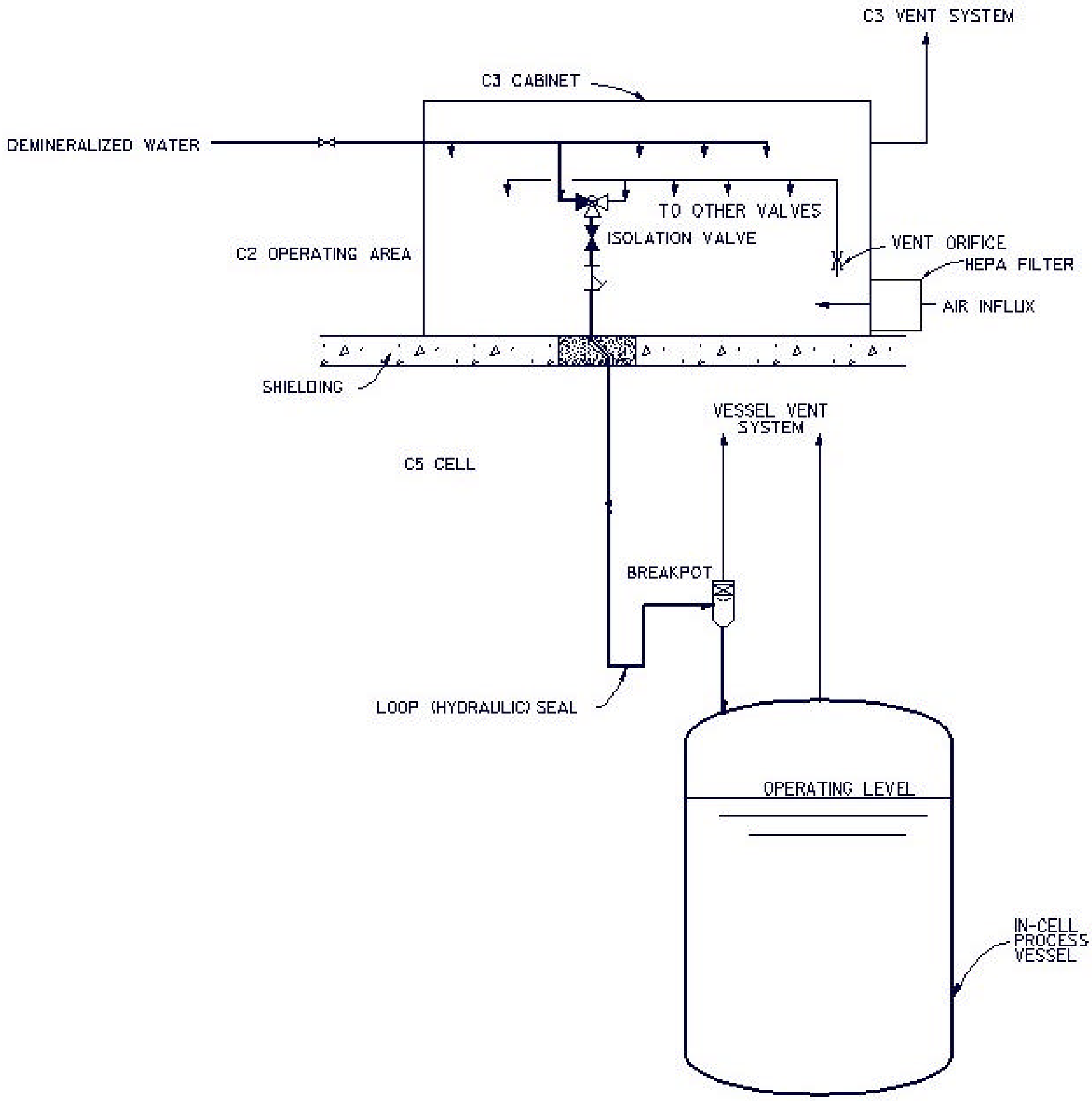


Table 2.5-3. Demineralized Water System

Fault	Important to Safety SSCs	Safety Function	Design Safety Feature
Backflow of activity through the water supply from vessel environment into the operating area	Loop seal	Loop seal provides a seal between the in-cell vessel environment and the operating area.	Periodic filling of the loop seal.
	Valves and self-sealing couplings	Valves and self sealing couplings provide isolation between the in-cell vessel environment (C5) and the process water feed system cabinet operating area (C3)	Administrative controls to ensure disconnection of process water supply and closure of valves when supply is not in use.
	Cabinet	The cabinet provides a barrier between the C3 environment and the operating area (C2) in the event of a failure of the loop seal and valves/couplings	Administrative controls to ensure that the cabinet access doors are closed and locked C2, C3 and C5 ventilation systems operating See Section 2.2.1, Process Building Ventilation System

2.5.4. Steam Supply System

2.5.4.1. Purpose

The purpose of the steam supply systems within the TWRS-P facility is to heat process streams and to provide a motive fluid for steam ejectors.

2.5.4.2. Description

Low pressure steam is supplied to a number of operations within the process for the purpose of heating. The steam supply pressure is 2.76 barg and the supply temperature is 142 °C. Low pressure steam is also used for heating building inlet air within the HVAC system. The steam supply (both HPS and LPS) operate in a recirculation system with condensate from each system being returned to the boiler. Periodic blowdown and subsequent top-up of the circuit minimize the level of solids buildup within the boiler.

Process operations requiring steam heat are designed by the process engineering department to ensure the appropriate size and geometry of the heat exchanger selected. Shell and tube heat exchangers are normally employed for duties that require heating of a process stream. Jacketed vessels or heating coils are normally employed for heating of materials within vessels. Principal users of steam heating are the vacuum evaporators that operate at a subatmospheric pressure in order to lower the boiling point of the material being evaporated.

Steam is introduced to the in-cell operations via confinement located out-of-cell. Steam is distributed from the main supply to the various users through the out-of-cell confinement. Typically, out-of-cell confinement will supply between 4 to 20 in-cell applications. The control and isolation valves to each of the applications are located within the confinement. The usage requirements for the plant will determine the degree of automation applied to the steam supply system. Typically, infrequent liquid transfers (i.e., plant wash) would be operated manually.

Figure 2.5-6 shows a schematic of the steam supply and control valves.

2.5.4.3. Hazardous Situations

The identification of the potential hazardous situations resulting from the unavailability of the stream supply system to the various process users has yet to be addressed in detail. At this time, the stream supply system is not considered ITS. The hazardous situations listed below refer to those known during the operation of the stream supply system.

1. Contamination of the Control Valves

When a steam control valve is closed, the residual steam in the feed line condenses forming a partial vacuum. This vacuum can draw active liquor up into the control valve (see Section 2.6.3, Steam Ejectors).

2. Failure of steam line in-cell challenges cell ventilation system.

The set of Important to Safety SSCs from the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Figure 2.5-6. Steam Supply Cabinet and Control Valves

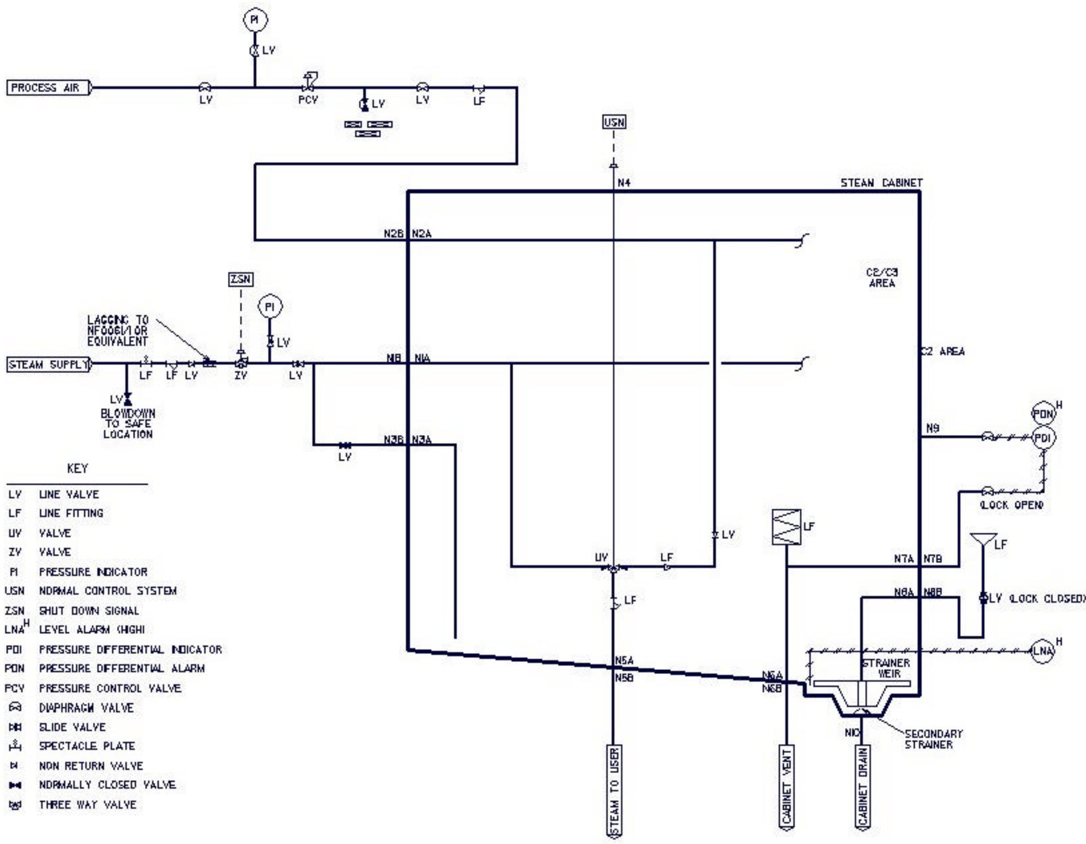


Table 2.5-4. Steam Supply Systems

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Failure of steam line in-cell challenges cell ventilation	Steam lines, steam ejectors	Maintain pipe integrity	See Section 2.1.2, Piping In-cell piping integrity

2.5.5. Plant Wash System

2.5.5.1. Purpose

The purpose of the TWRS-P facility wash supply system is to provide a means for in-situ decontamination of plant items that have been in contact with radioactive liquors either by intent (vessels and pipework) or following an unusual occurrence such as spillage to cell floor. It also provides a means for preventing the buildup of solids within systems. The plant wash system also is a key feature necessary to support deactivation of the plant.

Within the plant, there will be provisions for applying demineralized water or other wash media to periodically wash active equipment or components. Wash lines are provided to all process vessels, the cell liner, pump bulges, flushing of ultrafilters etc. The design methodology for plant washing within the TWRS-P project was outlined during part A in the report, *Process Design Guide – Plant Wash Operations*, K0104/REP/ 103/PRC. As the design progresses for part B1, the details of the plant wash systems will be specified.

2.5.5.2. Description

For vessels, plant wash water will be applied through one or more circular wash rings mounted generally above the tangent line of the vessel top dished end. The wash rings allow washing of radioactive liquors off the upper dished end weld. The wash water will also provide washing of the vessel/column walls and column packing as necessary. In some cases, the wash rings may be located at the base of the vessel to provide additional washing. Wash systems will be provided where there is the potential for solids to accumulate within systems. Finally, plant washing will be used to flush pumps and valves to reduce the potential dose uptake to operators during plant maintenance activities.

The plant wash water is supplied from sources outside the process cells. Delivery of the plant wash water to the in-cell plant items will be via a number of operator accessible points, where connections between the plant wash service and the in-cell plant item are made. For operational plants at Sellafield, BNFL locates the connections within a plant wash cabinet. The plant wash cabinet provides sustainable confinement for the first out-of-cell demountable connections. They also provide safe access, operation, and maintenance of the associated plant wash supply equipment within the confines of the cabinet. The individual wash lines from the plant wash cabinet pass into the cell through a floor box located in the biological shield. The wash line is connected to the plant wash ring by a welded connection on the plant item. On the plant wash line, a loop seal is designed to provide a hydraulic seal between the vessels, ventilation system, and the cabinet ventilation system. The loop seal also prevents the passage of radioactive vapors from the vessel into the cabinet. Figure 2.5-7 provides a schematic of a plant wash system. A design guide for plant wash cabinets has been prepared for the TWRS-P Project (*Design Guide for Plant Wash Cabinets”* – K70DG633).

The number of plant wash cabinets will be determined from the in-cell layouts and wash requirements of the in-cell plant during Part B1.

2.5.5.3. Hazardous Situations

The identification of the potential hazardous situations resulting from the unavailability of plant wash to the various process users has yet to be addressed in detail. At this time, the plant wash supply system is not considered ITS. The hazardous situations listed below refer to those known during the operation of the demineralized water system.

1. Back contamination of water supply resulting in a potential dose to plant workers

2. Overfilling of the in-cell vessel leading to the movement of active material out of the in-cell shielded area. Overfilling protection is addressed under shielding and confinement (i.e., loss of confinement due to overfilling vessel).

Figure 2.5-7. Plant Wash Supply System.

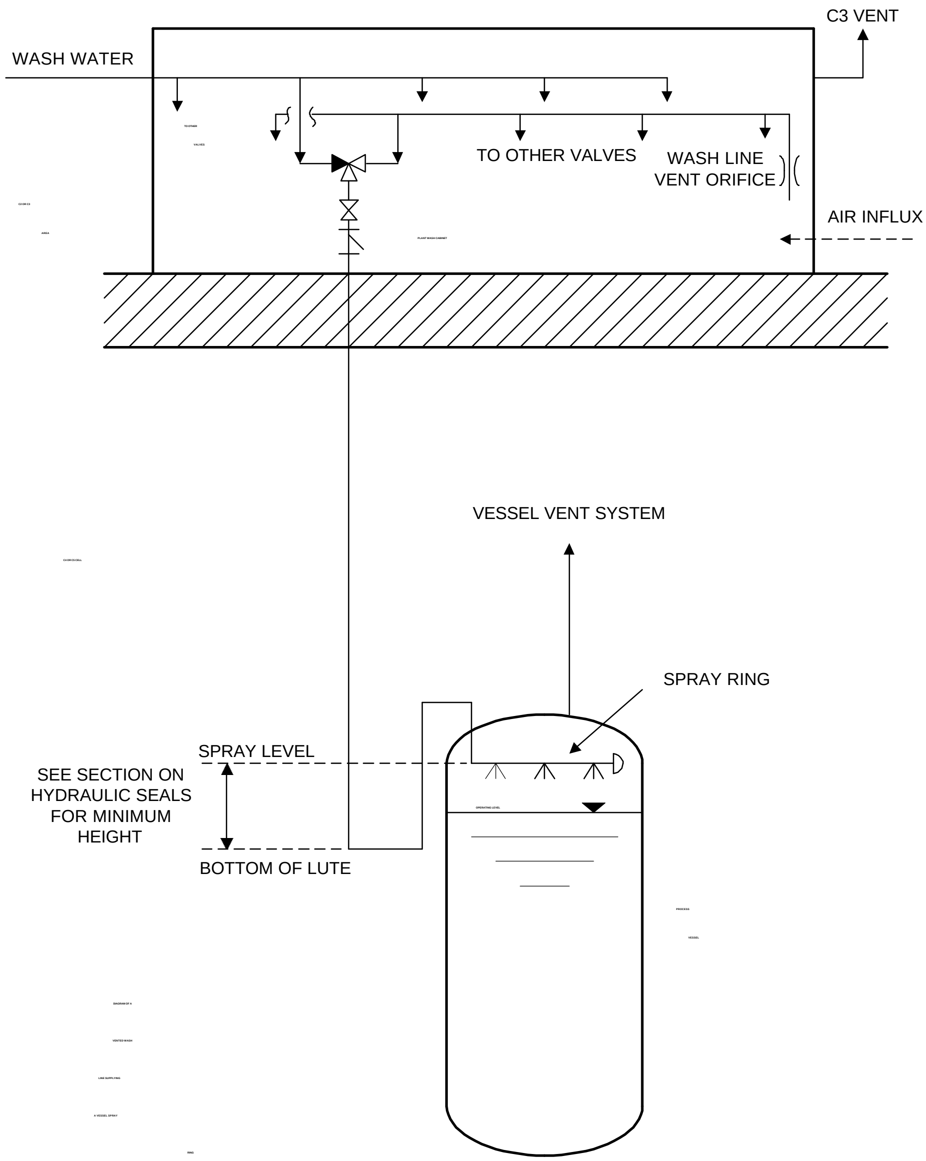


Table 2.5-5. Plant Wash Supply System

Fault	**Important to Safety SSC's**	**Safety Function**	**Design Safety Feature**
Backflow of aerosols or vapors from the in-cell vessel into operating areas	Loop seal	Loop seal provides a seal between the in-cell vessel environment and the operating area.	Periodic filling of the loop seal and pipework configuration that ensures that water in loop seal will not siphon and hence loss of seal.
	Valves and self-sealing couplings	Valves and self-sealing couplings provide isolation between the in-cell vessel environment (C5) and the plant wash cabinet operating area (C3)	Administrative controls to ensure disconnection of plant wash supply and closure of valves when supply is not in use.
		The cabinet provides a barrier between the C3 environment and the operating area (C2) in the event of a failure of the loop seal and valves /couplings.	Administrative controls to ensure that the cabinet access doors are closed and locked C2, C3 and C5 ventilation systems operating See Section 2.2.1, Process Building Ventilation Systems
Backflow of activity through siphoning	Cabinet location	Cabinet is located at a barometric head above the vessel liquor level The plant wash line is located below a liquor surface	Barometric leg requirement is checked during design and installation
	Valves	Three-way valve located in the cabinet ensures venting of the wash line	Venting following the transfer of plant wash liquor is automatically provided as part of the normal valve operation for submerged wash lines
	Continuous area monitor	Mitigation of operator dose uptake under fault conditions	Trouble alarm battery-backed inspection

2.5.6. Solid Cold Chemical Addition System

2.5.6.1. Purpose

Within the TWRS-P vitrification plant, the process requires the addition of solid cold chemical feeds. An area identified to date is the addition of glass formers to the LAW and HLW liquid feed to the melter. The feed system requirement is to allow the addition of cold chemicals while preventing the backflow of activity through the feed supply system.

2.5.6.2. Description

The cold chemicals (e.g., glass formers) will be delivered to the plant and stored before distribution to the facility. Glass formers are delivered to a series of hoppers located within the vitrification building and blended to the required recipe within another series of hoppers. The prepared glass formers pass into the process through a cascade of feed lock hoppers located in bulges that allow access for maintenance. The feed hoppers are interlocked to prevent a flowpath from the active area to the out-of-cell area. Each hopper is vented such that airflows are from the clean supply into the active area. The line to the waste/glass former blending vessel will be purged with air to minimize backflow activity.

Figure 2.5-8 is a schematic of the glass-former addition system.

2.5.6.3. Hazardous Situations

The identification of the potential hazardous situations resulting from the unavailability of the solid cold chemical addition system to the various process users has yet to be addressed in detail. At this time, the solid cold chemical addition system is not considered ITS. The hazardous situations listed below refer to those known for the operation of the solid cold chemical addition system.

1. Backflow of activity into feed preparation area giving rise to the potential dose to plant workers.

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Figure 2.5-8. Solid Cold Chemical Feed

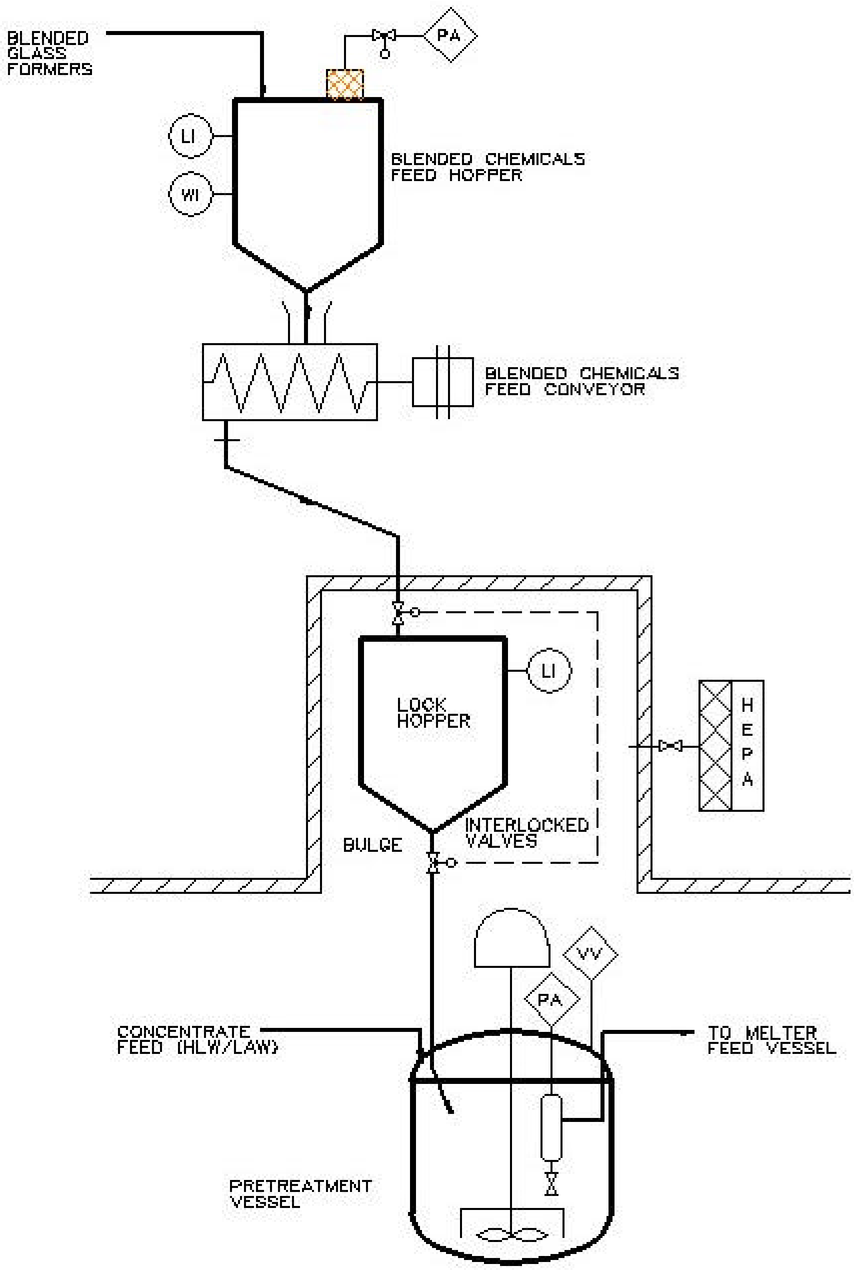


Table 2.5-6. Solid Cold Chemical Addition

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Backflow of active material into operating areas from the process cells via cold chemical supply line	Valves	A cascade system of feed hoppers and interlocked valves provide a barrier between the operating area and the in cell plant item.	Valves to fail closed Interlocking of valves ensure that there will be no open path for activity.
	Vessel, C3 and C5 ventilation systems	A flow of air from the out cell area into the process is maintained by the relative depressions of the ventilation systems.	Ventilation system DSFs Section 2.2 Ventilation

2.5.7. Cold Chemical Feed Systems

2.5.7.1. Purpose

The TWRS-P process contains a number of unit operations where cold chemicals are added. The cold chemicals used in the process are detailed in the TWRS-P Basis of Design document. Cold chemicals such as nitric acid, sodium hydroxide, and iron nitrate are added batchwise to the process unit operations.

2.5.7.2. Description

Cold chemicals will be delivered by tanker to the cold chemical storage area. From the cold chemical storage area, transfers will be made to cold chemical feed tanks located out cell but connected to the in cell unit operation. The cold chemicals will be adjusted to their required process concentration by:

- In-line mixing between the cold chemical storage area and the feed delivery tank, or
- Batch makeup in the feed tank to the process.

In both cases, analysis by sampling or by on-line measurement will be performed to confirm the correct cold chemical feed strength. All cold chemical feeds will be added to the process by gravity flow or pumped flow via an isolation valve and loop seal. The cold chemical feedline to the process can be directly in the vessel or introduced through an existing breakpot. The cold chemical feedline will not be submerged in the active liquid(s).

2.5.7.3. Hazardous Situations

The identification of the potential hazardous situations resulting from the unavailability of cold chemical feed systems to the various users has yet to be addressed in detail. At this time, the cold chemical feed systems are not considered ITS. The hazardous situations listed below refer to those known during the operation of the various cold chemical feed systems.

1. Backflow of activity into the operating area via the feed line connecting the cold chemical feed tank and the in cell vessel

2. Addition of out of specification cold chemicals to the process causing the degradation of the unit operation (e.g., reaction of concentrated nitric acid with the ion exchange resin) giving rise to over-pressurization.

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Figure 2.5-9 provides a schematic of the Cold Chemical Feed Systems.

Figure 2.5-9. Cold Chemical Feed System

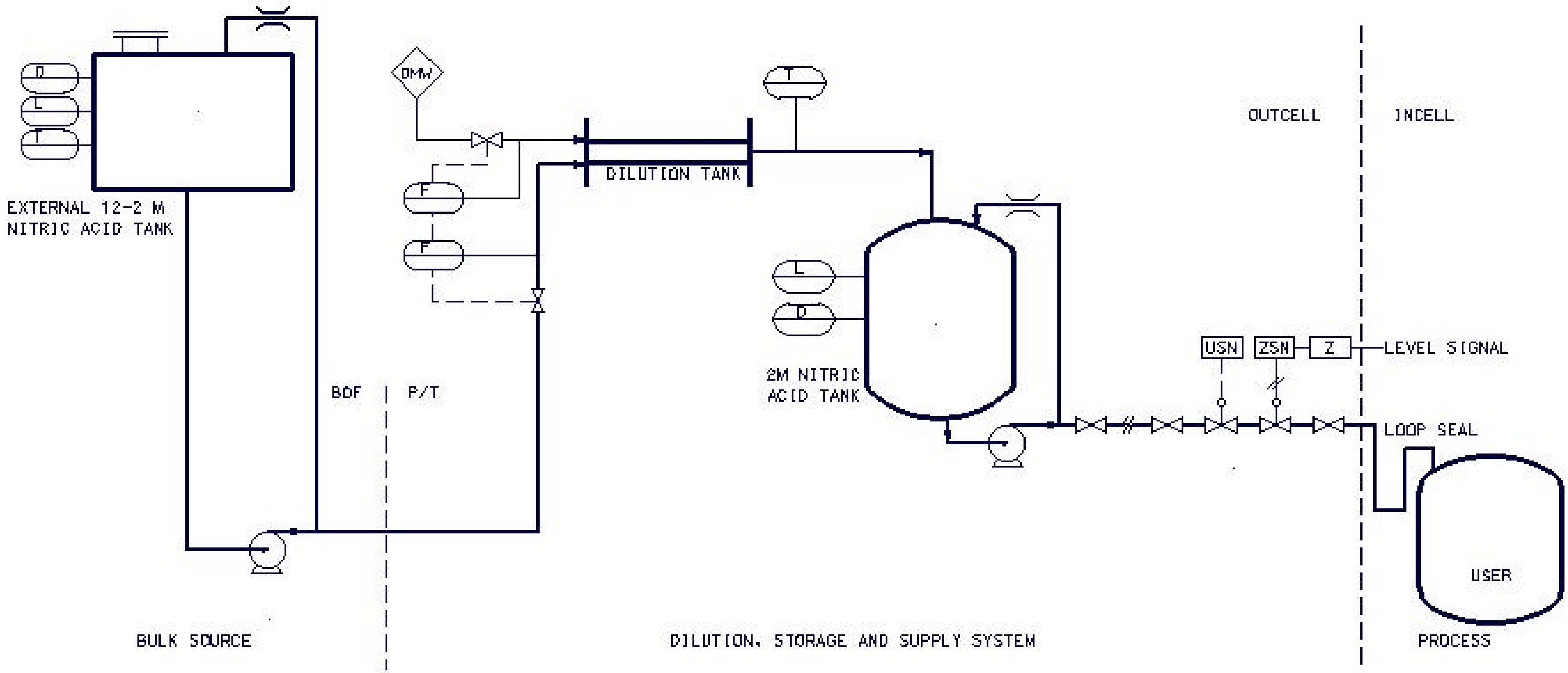


Table 2.5-7. Cold Chemical Systems

Fault	Important to Safety SSCs	Safety Function	Design Safety Feature
Failure of the operational controls that prevent the wrong concentration/volume of chemical to be sent to process system For identification of specific faults (See Section 2.8, Unit Operations)	Sampling	Confirm composition of Cold Chemical	Administrative controls to ensure sampling is carried out.
	On line measurements - density, or - conductivity	Confirm composition of Cold chemical where chemical properties allow	Maintenance/calibration Precheck on cold chemical addition to inhibit feed if on-line measurement or sampling show incorrect cold chemical concentration, where appropriate (e.g., nitric acid feeds) diverse instrumentation provided
	Volume measurements	Verify proper volumes of chemicals	Maintenance/calibration Trip based on volume of cold chemicals fed to process.
Failure of the barriers that prevent the backflow of activity into Cold Chemical makeup area	Loop seal	Loop seal provides a seal between the in-cell vessel environment and the operating area.	Periodic filling of the loop seal.
	Valves and piping	Valves and piping provide isolation between the in-cell vessel environment (C5) and the vessel (outside)	Administrative controls to ensure closure of valves when supply is not in use.
	Ventilation system	Maintain depression within cell.	C5 ventilation systems operating. See Section 2.2.1, Process Building Ventilation System

2.5.8. Cold Chemical Receipt and Storage Systems

2.5.8.1. Purpose

The TWRS-P process requires the use of a variety of cold chemicals. These are listed in the TWRS-P Basis of Design document. The purpose of the cold chemical receipt and storage systems are to receive chemicals from the tanker trucks, store the chemicals until required, and deliver the chemicals to the plant cold chemical feed systems.

2.5.8.2. Description

Cold chemicals will be delivered to the TWRS facility by tanker trucks. The chemicals will be transferred from the tanker trucks into storage vessels located outside the three main process buildings. Dedicated vessels and areas will be provided for each of the cold chemicals. When needed, the cold chemical will be pumped, via a distribution system, to a feed or makeup vessel located near the unit operation using the chemical.

2.5.8.3. Hazardous Situations

The hazards associated with the Cold Chemical Receipt and Storage System are:

1. Release of hazardous cold chemicals to the plant workers by spillage and/or by release of vapors. For example, the potential for inhalation of harmful gases such as NOx and ammonia, or for chemical burns through skin contact with nitric acid.

2. Pressurization of vessels and release of hazardous chemicals into the operating areas from the mixing of incompatible cold chemicals within the feed system or storage areas.

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Table 2.5-8. Cold Chemical Receipt and Storage System

Fault	Important to Safety SSCs	Safety Function	Design Safety Feature
Breach of Confinement leading to the release of hazardous cold chemicals into the operating environment.	Vessel	Prevention of the release of hazardous cold chemicals.	Vessel Integrity (out-of-cell vessel) See Section 2.1.1, Vessels Dedicated and vent pipe with local filter scrubbing equipment where appropriate For in-plant vessels, sequence interlocks to prevent overfilling
	Metal Posts	Barrier protection around the vessel and pipework	Designed to withstand the impact of a tanker truck.
	Pipework, connections and pumps	Prevention of the release of hazardous cold chemicals	Pipe integrity Robust couplings Minimize the use of flanges and provide drip trays under pumps Testing and inspection of flanges
	Shield	Prevent sprays from contacting the operators	Splash guards around pumps Chemically compatible splash guards
	Environmental Monitoring	Detection of hazardous vapor releases	Audible alarm on detection of vapor release, battery back, trouble alarm.
	Berms	Collection of hazardous materials to prevent spread	Separate berms for each cold chemical Compatible with the material handled Provide sufficient capacity to hold cold chemical delivered
	Level instrumentation	Shut off transfer upon detection of spray or spill	Level detection in the berms to alarm on the event of spillage
	Emergency Stop	Manual shutoff of transfer	Located accessible for operator action
	Valves	Isolate feed system	Simple design (e.g., ball plug)

Table 2.5-8. Cold Chemical Receipt and Storage System

Fault	Important to Safety SSCs	Safety Function	Design Safety Feature
Inadvertent mixing of incompatible chemicals	Piping and couplings	Prevent mixing of incompatible chemicals	Unique couplings that prevent wrong hose connection from tanker to vessel
	Drainage pipes	Prevent inadvertent mixing in storage area	Segregation of drains from cold chemical vessels, i.e., individual berms and drainage or emptying routes

In addition to the specific design safety features described above, the following would be provided: protective clothing, self-contained air suits, eye baths, spillage confinement equipment.

2.5.9. Liquid Effluent Discharge System

2.5.9.1. Purpose

The purpose of the liquid effluent discharge systems within the TWRS plant is to provide a means of collecting, monitoring and discharging spent liquids from the plant. Only the radioactive dangerous liquid effluent discharge and the non-radioactive, non-dangerous liquid effluent discharge systems will be considered since these systems could result in the release of radioactivity into the environment.

2.5.9.2. Description

The radioactive, dangerous liquid effluent system collects, samples, and discharges the process liquid effluents that are potentially contaminated. Within TWRS-P, this system receives condensate from the evaporator overheads condensers, specific cell washings, out-of-specification non-radioactive condensate, and a variety of other potentially radioactive liquid wastes.

The radioactive, dangerous liquid effluent system provides an effluent collection vessel which receives liquids from a breakpot(s). The liquid in the collection vessel is sampled to determine the level of contamination. If the liquid is not contaminated, it can be sent to the non-radioactive liquid discharge system. If slightly contaminated, the liquid effluent is sent to the low active effluent system, which is routed to the LERF/ETF. If the liquid effluent contains sufficient activity to be classified unacceptable for discharge, it is recycled back to the process.

The non-radioactive, non-dangerous liquid effluent system collects, samples, and discharges a wide range of liquid effluents generated during processing but are not in direct contact with process liquids. These liquids include non-radioactive plant washdown liquids, boiler water blowdown, and any other liquid wastes and condensates generated during facility operations that should not normally contain radioactivity. The waste is sampled to ensure it complies with discharge authorization limits. When the sample results are received, the waste is sentenced. If it falls within the limits the liquid is discharged to the LERF/ETF. If the liquid exceeds the specification for non-radioactive waste, it is routed to the radioactive liquid effluent system for treatment or routed back to the process.

The pipework design of the system slopes all effluent lines to ensure they are self-draining to the collection vessel to minimize the inventory in the lines in the event of contamination and to facilitate easier maintenance.

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features for each ITS SSC.

Figure 2.5-10 shows a schematic of the Liquid Effluent Discharge System.

2.5.9.3. Hazardous Situations

The hazards associated with the Liquid Effluent Discharge System are:

1. Release of radioactive material into areas where contamination and/or excessive radiation dose could occur.

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features for each ITS SSC.

Figure 2.5-10. Liquid Effluent Discharge

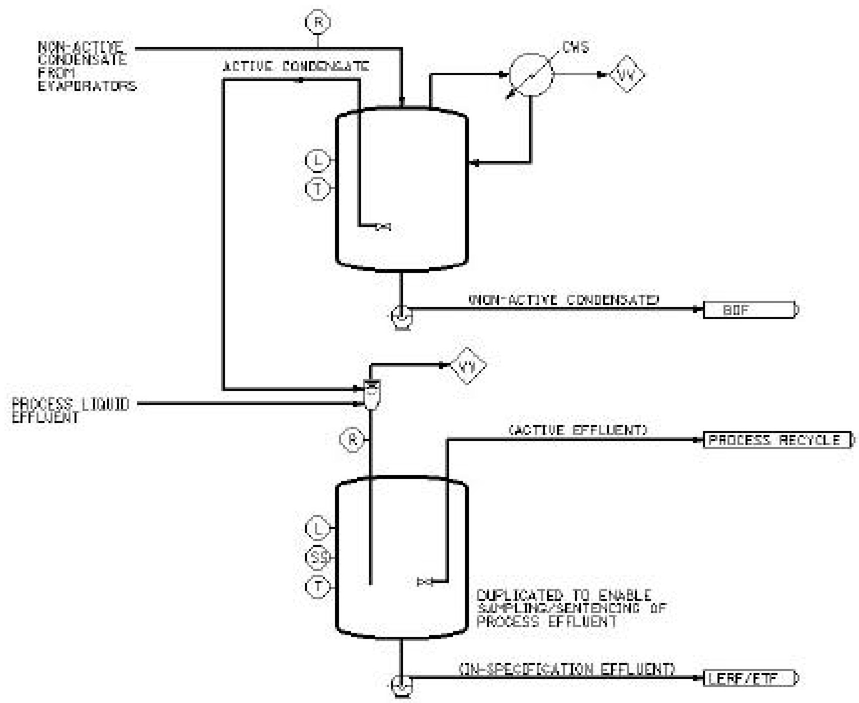


Table 2.5-9. Liquid Effluent Discharge Systems

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Release of dangerous/radioactive waste that exceeds limits of receipt facilities	Sampling	Sampling and the hold up of liquid effluents until an acceptable sample result is obtained.	Administrative controls to ensure that a representative sample is taken and that transfer of liquid is only carried out on receipt of an acceptable sample result. Representative samples are achieved by the use of process sequences. The sample sequence will call up the agitation of the vessel contents (if not continuous agitation) prior to the sample being taken. Inhibits are placed on the transfer until an acceptable sample result has been received.
	Gamma Monitoring	Detection of liquid effluent with higher radiation levels.	Trouble alarm functional test redundant.
	Valves	Redirects or stops the transfer of liquid effluent with higher radiation levels	Automatic valve, fail-safe mode Defense in Depth In addition process controls through sampling, physical segregation of the active and inactive liquid streams and knowledge of process conditions upstream of the discharge vessels provides further protection against the release of unacceptable discharges.

2.5.10. Sampling System

2.5.10.1. Purpose

For high frequency sampling, and for highly active, medium active, and some transuranic bearing samples, the company is committed to designs that include the use of automatic sampling systems. Manual sampling techniques are primarily reserved for low active, low frequency, and high-volume sample applications, or where needle-sampling methods are inappropriate.

To limit manual intervention, pneumatic transfer methods are widely used throughout industry and are applied extensively and reliably within BNFL's Sellafield plants for the transport of radioactive materials.

The objectives are to:
- provide a safe and cost effective proposal
- minimize manual intervention where practicable, incorporate ALARA principles
- optimize the use of tried and tested techniques with proven reliability
- employ a liquid and solid waste minimization policy.

All equipment designs provide for maximum availability and minimum maintenance during the intended plant working life.

The frequency of material samples will depend on the requirement for the sample.

2.5.10.1.1. Sampling Categories

There are four sampling categories:

1. Accountancy: To record the composition of feeds received by the plant and to record the composition of discharges from the plant. Discharges cover both products and secondary wastes.

2. Control: To determine whether the next operating sequence can be started.

3. Frequent Monitoring: To monitor plant performance on a regular basis.

4. Infrequent Monitoring: To monitor plant performance on an infrequent basis. These samples are operator initiated. This may result, for instance, from a need to determine the cause of a maloperation.

2.5.10.2. Description

Approximately 30 samples per day will be pneumatically transferred to the laboratories for analyses. The system allows for a maximum sample liquor volume of 25 ml. To enable safe handling, sample liquor will be diluted (within a shielded enclosure in the laboratory) and then transferred to the analytical equipment.

All liquid samples are delivered to the sampling points by dedicated sampling RFDs (Reverse Flow Diverters). This sampling delivery method is used extensively on existing BNFL plants.

RFD fed sampling systems have no requirement for pre-evacuated sample bottles. The circuit is made once the bottle is impaled on the sampling needle tip. Details of a sample needle are shown in Figure 2.5-11. The bottle is effectively evacuated during the RFD pulsing operations. A small volume of sample liquor is then drawn into the bottle until line and bottle pressures are equalized. To a limited extent, subsequent pulses will increase the sample volume.

A small weir within the bottle prevents the previously captured sample being discharged while the RFD is performing the next pulse. If subsequent RFD pulses can not obtain a sufficient volume, then two (or more) coincidental samples can be obtained using two (or more) sample bottles. The RFD system is shown in Figure 2.5-12.

Where required, adequate wash facilities will be provided to flush the system of the previous sample liquor and also to keep the sample delivery tubing as clean as possible.

Experience has shown that if the RFD is operated before the sample bottle is impaled on its needle, liquor release does not occur. This feature permits liquor recycling prior to obtaining the sample and assists in obtaining a fully homogenized and representative sample.

2.5.10.2.1. Autosamplers - General

The purpose of the autosampler is to facilitate the automatic transfer of the sampled liquid from a sampling needle into a sample bottle. The autosampler will then insert the bottle into a carrier ready for its pneumatic transfer to another location. Each autosampler is capable of taking a sample from any of the six needles installed within the device.

Typically, a programmable logic controller (PLC) is used to drive the autosampler through its sequences. These sequences include the routine sampling cycles and the automatic removal and replacement of disposable needles.

The autosampler is comprised of a number of mechanical sub assemblies and a separate local control cabinet. Automatic sampling and needle renewal cycles are performed sequentially by “sub units,” controlled and monitored by the local control cabinet. The automatic cycle commences when a carrier arrives in the autosampler docking unit from the pneumatic transfer system. A proximity switch detects the arrival of a carrier. The carrier also provides secondary confinement for the sample while it is in transit through the transfer system.

The sampling chamber robotic arm may be operated manually (by hand winding) using the tools provided. The initial settings to datum and maintenance operations are performed in this manner, with all power supplies deenergized.

2.5.10.2.2. Autosamplers - Description

Autosamplers can be floor or wall mounted and with either right-hand or left-hand orientation. A typical shielded, right hand oriented, floor mounted autosampler is shown in Figure 2.5-13.

The autosampler is a confinement fitted with six sampling needles and a robotic arm. The device can transfer sample bottles from (and to) its docking port, to (and from) the selected sample needle.

The initiation of a separate liquor lift system delivers the liquor to be sampled to the selected needle position.

The robotic arm is driven in vertical and rotary motions by drive systems on the outside of the autosampler confinement.

The sample carrier is jacked up to seal with the docking port to allow the robotic arm to interface and transfer the sample bottle between carrier and needle.

Below the docking port is a "docking unit" which receives/returns the carrier from the pneumatic transfer system. The carrier is rotated from horizontal to vertical, then lifted automatically up to the docking port.

There are facilities for checking that the robotic arm is sealed at the top of the docking port (Upper Interspace Leak Test) and that the carrier is sealed to the underside of the docking port (Lower Interspace Seal Test). The seal tests ensure that the chamber confinement is not broken during these operations.

The confinement is normally vented via the drain line, typically to the vessel ventilation system.

Although considered to be an infrequent requirement, a process water spray to reduce the build-up of activity around the sample needles and is used to wash the confinement.

There are provisions to introduce tools to allow the automatic removal and replacement of the sampling needles. The nozzles (to which needles are attached) can also be released, removed and replaced, using the dedicated tools provided.

Autosamplers can be surrounded by heavy lead shielding (encased in steel fabrications), lightly shielded or unshielded as requirements dictate.

2.5.10.2.3. Controlled Arrival Facility

The transfer system is designed to deliver the sample bottle carrier to the autosamplers, laboratory receipt or laboratory dispatch facilities at approximately 6 m/s. To prevent damage to either the carrier or the docking unit, the carrier is decelerated to rest and then "soft-docked," (i.e., drawn into the docking unit in a more controlled manner). This is accomplished by the operation of the 4-way soft arrival valve.

To minimize radiation dose to an operator who may be present when a sample departs, a rotary shut-off valve rapidly opens to allow an inrush of air to accelerate the carrier up to its travel velocity. The section of transport pipe, through which acceleration and deceleration takes place, may also be shielded.

2.5.10.2.4. Laboratory Receipt Facility (LRF)

The Laboratory Receipt Facility (LRF) is a shielded device, which operates similarly to the autosamplers. The LRF receives a carrier (holding a filled sample bottle), via a controlled arrival facility. The device automatically removes the bottle from the carrier, transfers the bottle to the dispatch chute where it falls under gravity into the shielded “Sample Receipt, Preparation and Dilution Station” located within the laboratories. After performing this operation, the LRF reassembles the carrier and makes it available for dispatch.

There are no requirements for manual intervention during the normal operation of the LRF.

Prior to dispatch, each carrier is monitored to ensure that the previous sample bottle confinement has not been lost. In the unlikely event of unacceptably high levels of radioactivity being detected, the carrier is pneumatically transferred to the Contaminated Carrier Receipt Facility (CCRF). "Clean" carriers are (pneumatically) transferred to the Carrier Receipt and Bottle / Carrier Transfer Facility (CR&BCTF), ready for reuse.

All liquid samples will be transported automatically to the shielded Laboratory Receipt Facility (LRF). The device is located directly above the laboratories. The proposed automatic sampling system is shown in Figure 2.5-14.

2.5.10.2.5. System Operation

The automatic sampling system consists of a number of pieces of equipment, connected together by pipework and controlled so that the bottled samples of radioactive material can be transported from one point to another with minimal manual intervention (see Figure 2.5-15).

The control system commands that clean (new) bottles within carriers be transported from the Carrier Receipt and Bottle/Carrier Transfer Facility (CR&BCTF), through the pipe system to the required manual or automatic sampling station. On carrier arrival, the autosampler automatically removes the bottle from the carrier, arranges for the dispensing of the sample (by sequentially impaling then removing the bottle on and off the correct needle), and then reinstates the bottle inside the carrier.

The control system then commands the loaded carrier to return to the LRF (located above the laboratories) where the bottle is removed and transported automatically to laboratories. The empty carrier is monitored and, if clean, is automatically transported to the Carrier Receipt and Bottle/Carrier Transfer Facility where it is stored and available for its next duty.

Each carrier journey is timed. Should the journey time exceed prescribed limits, an indication is provided that the carrier felts are approaching the end of their useful life. At this point, and to avoid any risk of a carrier not reaching its destination, the felts are changed. Carriers are designed to make the seal replacement task a simple operation. Clean carriers requiring maintenance will be posted out of the CR&BCTF and posted into the Carrier Maintenance Facility and Store (CMF&S).

Diverters provide junction points and enable the carriers to be routed to and from any of the sampling devices. Tracking switches, positioned at strategic locations on the pneumatic transport lines, monitor the carrier progress through the system.

The Carrier Receipt and Bottle/Carrier Transfer Facility, located at the analytical laboratories, serves the following functions:

- Installing sample bottles into carriers.
- Introducing bottle carriers into the pneumatic transfer system.
- Installing replacement needles into needle change carriers.
- Dispatch of needle change carriers into the pneumatic transfer system.
- The identification of sample bottles (bar code reader installed).
- Splitting of carriers for sample bottle introduction.
- Storage of bottles.

Under no circumstances will loaded carriers be dispatched to the unshielded Carrier Receipt and Bottle/Carrier Transfer Facility.

Carriers are routinely monitored at the LRF to check for evidence of contamination. Contaminated carriers are dispatched directly to the Contaminated Carrier Receipt Facility (CCRF). Clean carriers requiring maintenance are transported to the Carrier Maintenance Facility and Store (CMF&S).

To perform the posting in and posting out operations, Central Research Laboratories (CRL) or similar bagless transfer systems are fitted to the CCRF, the CMF&S and the CR&BCTF.

2.5.10.2.6. Sample Transfer

It is intended that all liquor samples will be transported within the building to the laboratories for analysis via a pneumatic transport tube employing a vacuum supply to convey the sample in a robust and sealed carrier at approximately 6 m/s (~ 13 mph). Design teams will fully assess the interbuilding routing options during system detailed design.

Sample carrier tracking switches are proposed at strategic positions, therefore, the non-arrival of a carrier is swiftly detected and (remote) remedial action can be taken. Carriers will be recovered automatically, avoiding manual intervention, by reversing exhausters and redirecting the carriers to a “safe” location.

When routing the transport pipework, every attempt will be made to avoid high occupancy areas.

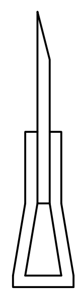
2.5.10.3. Hazardous Situations

The following hazardous situations associated with the Sampling System give rise to the potential dose to plant workers:

- Loss of primary or secondary confinement (i.e., sample bottle)
- Spread of contamination from carrier
- Dose from stationary carrier and carrier in transit
- Excessive dose from samples during analyses

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Figure 2.5-11. Sampling Needle.



(not to scale)

Figure 2.5-12. Typical RFD Fed Sample Point

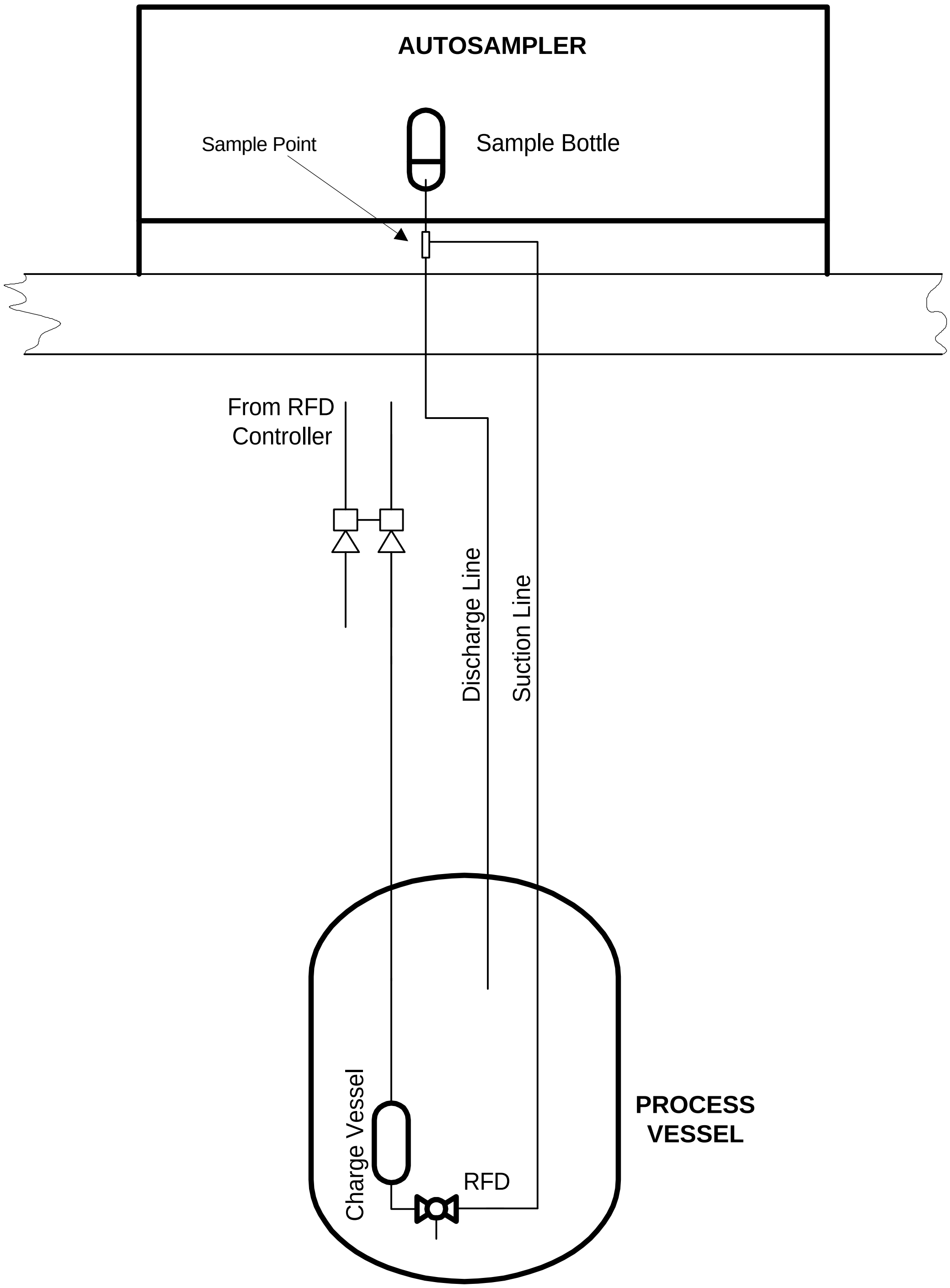


Figure 2.5-13. Proposed Arrangement of Automatic Sampler (Autosampler).).

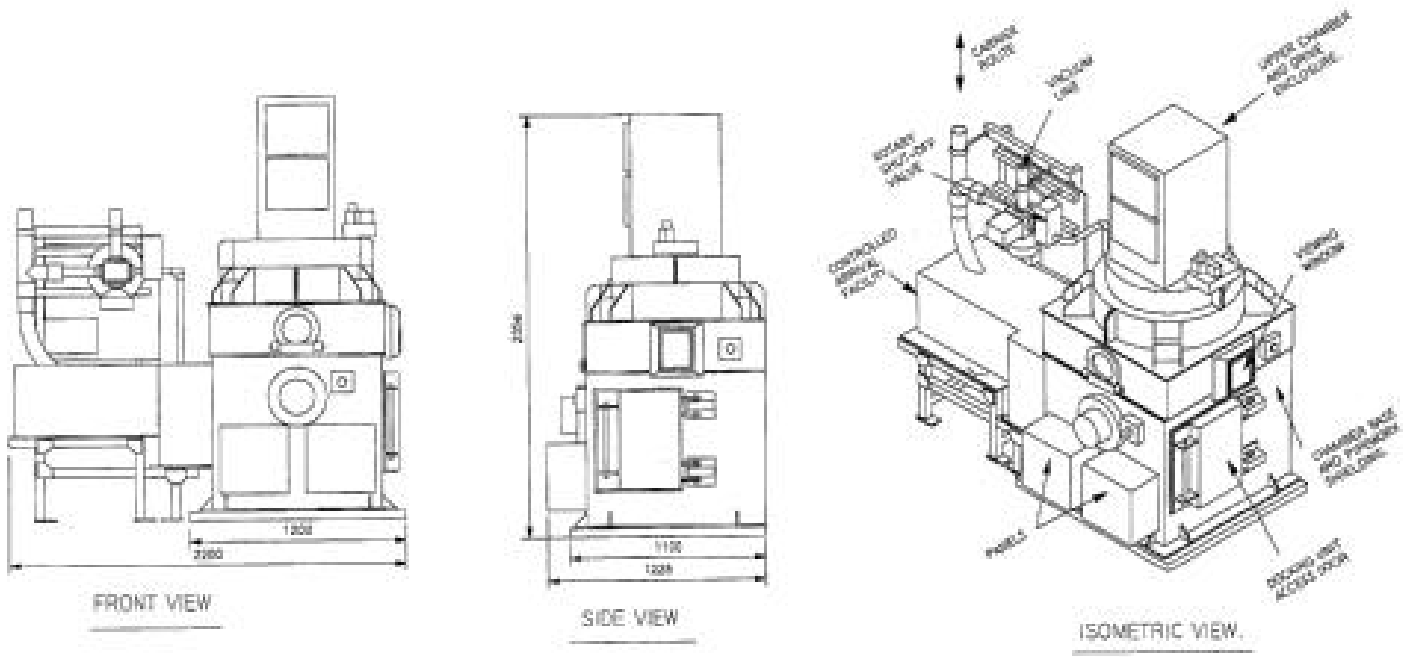
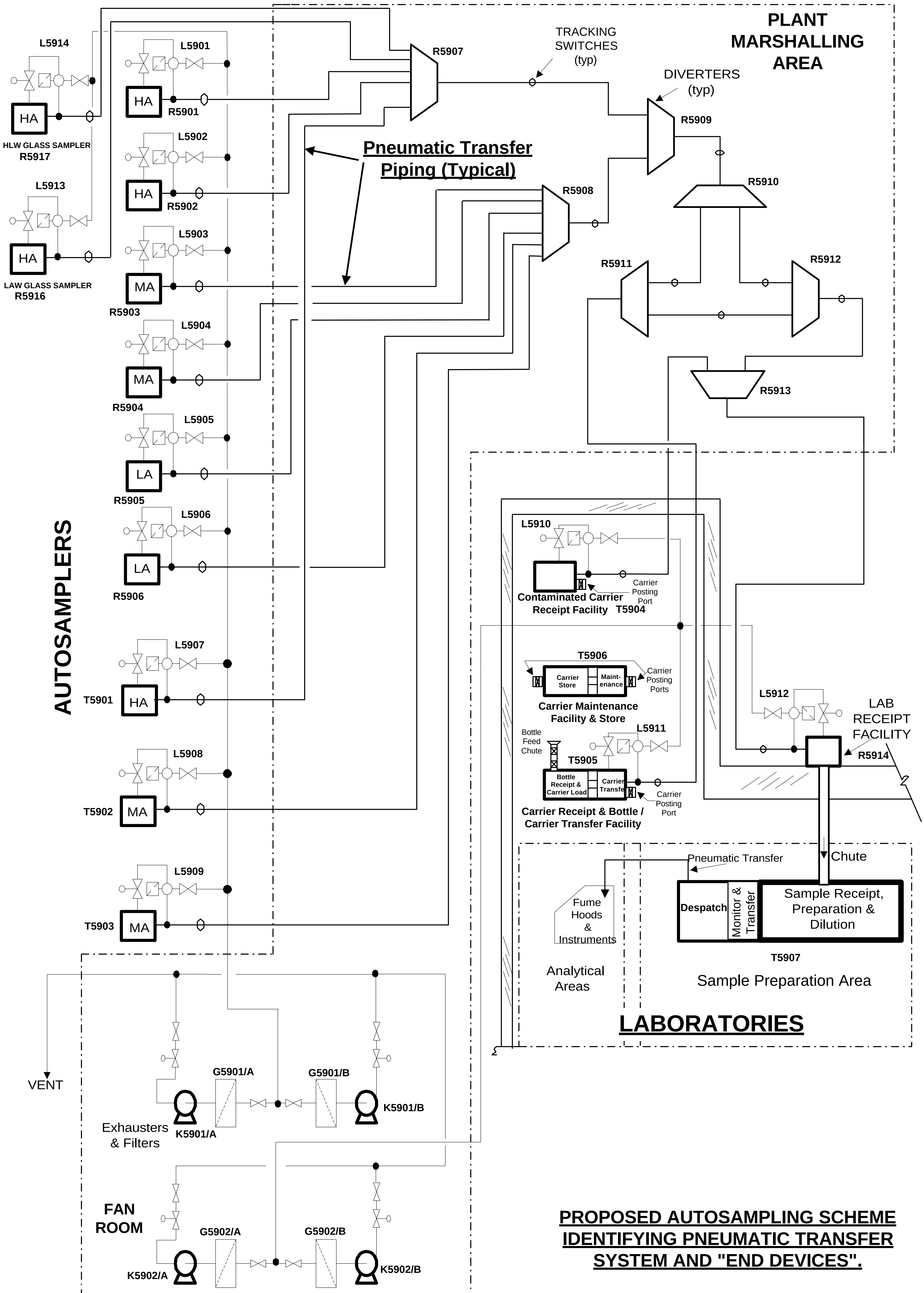


Figure 2.5-14. Proposed Autosampling Scheme .



PROPOSED AUTOSAMPLING SCHEME IDENTIFYING PNEUMATIC TRANSFER SYSTEM AND "END DEVICES".

Figure 1

Figure 2.5-15. Carrier.

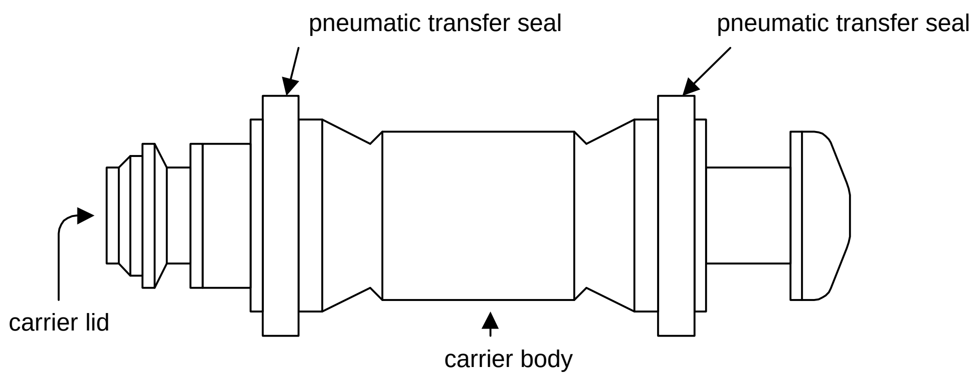


Table 2.5-10. Sampling System - Autosampler

Fault	**Important to Safety SSC's**	**Safety Function**	**Design Safety Feature**
Sample bottle failure, leading to loss of primary confinement during normal bottle transfer	Sample bottle integrity	To maintain primary confinement during pneumatic transfer to the laboratories	Bottle stopper is self sealing and has a proven record of providing a reliable and maintained seal. Bottles and stoppers are manufactured from polyethylene and rubber, are used once only and disposed.
Damage caused to bottle during sample filling leading to breach of primary confinement	Automatic sampler mechanisms	Robotic arm movements follow the designated paths	Movements of the robotic arms are designed to eliminate the possibility of crushing or damaging a bottle. If the bottle cap is damaged (or the vacuum is broken), the bottle can not obtain a sample.
Sample needle becomes detached and remains impaled in the bottle leading to breach of primary confinement	Needle fixing mechanism	To remain attached to the sampling head	Needles are a one -piece assembly, designed so that they can not inadvertently detach and are changed at frequent intervals. Viewing window at the autosampler will allow supplementary visual inspection
Sample needle delivers liquor in the absence of a bottle being impaled leading to the spread of contamination	(Passive) anti-spitting tube	To prevent liquor delivery until a bottle is impaled Designed to provide dispensing of liquor only when a bottle is present	The bottle is evacuated during sample filling and relies on this partial vacuum to fill the bottle.
Bottle pressurization leading to the spread of contamination	Sample transport system and equipment design	To prevent increase in temperature during sample transit	All liquor samples are transported within the fabric of the building (relatively consistent temperature) If necessary to prevent chemical reaction pressurization, time delay prior to bottle removal from the needle assures system equilibrium
Carrier is not correctly assembled prior to dispatch leading to failure or loss of secondary confinement	Carrier integrity	To ensure carrier lid remains sealed to the body	<u>All</u> carriers are inspected on a daily basis. <u>All</u> carriers are dismantled, maintained, and thoroughly tested on a weekly basis

Table 2.5-10. Sampling System - Autosampler

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Carrier penetrates the system during pneumatic transfer leading to a radiation dose to workers	Bottle integrity	To maintain primary confinement	Bottle of self-sealing and has a proven record of providing a reliable and maintained seal
	Carrier design	To maintain secondary confinement	Carrier robustness, design and materials of construction
	Pipework integrity and configuration	To maintain tertiary confinement	Materials of construction. Number of changes in direction are minimized
	Airborne radiation (alpha/beta) and continuous area (gamma) monitoring with integral alarms	Warn personnel of high radiation and contamination levels in the vicinity	Redundancy, identification, functional testing, battery backed, trouble alarm, independent of normal instrumentation and control
	Carrier tracking switches	Monitors carrier travel through the transfer system	Fail-safe. Carrier transfer times are monitored and carrier conditions assessed
Dose to operator from stationary carrier in pneumatic transfer pipework	Carrier tracking switches and carrier "target" magnet	Monitors carrier travel through the transfer system	Fail-safe. Carrier transfer times are monitored and carrier conditions assessed. Carrier location can be detected remotely. Hard wired carrier detection devices. Carriers are routinely maintained
	Carrier retrieval flask	Permits carrier removal avoiding contact	Avoids manual intervention
	Automated sample tracking system and exhausters. Exhausters / power supply	To automatically perform fully automated carrier retrieval procedures	System is tested during commissioning and has a proven record of reliability. Exhausters are duplicated, (2 x 100%) and have a guaranteed non-interruptible power supply.
Loss of confinement from sampling chamber	Sampling chamber	To maintain a high level of confinement.	Wash facilities are provided within the chamber.
	C2, C3 and C5 ventilation systems	Vent extract required from the chamber	HEPA filter protects operators in the unlikely event of pressurization of the ventilation extract system.

Table 2.5-10. Sampling System - Autosampler

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
	Mechanical seals on drive shafts and robotic arm to chamber	To maintain confinement	Seal tests are carried out at every carrier receipt and dispatch operation
Spread of contamination from outer surface of a contaminated carrier	Sample transfer pipework and pipeline components (carrier monitoring positions)	To maintain confinement at all times and identify signs of contamination	Carriers are routinely monitored for surface contamination. A contaminated carrier is not used again until decontaminated or contaminated components are disposed
Dose to operator from a carrier containing the sample during flight	Exhausters, vacuum controllers	To maintain the requisite flight velocity (~ 6m/sec)	Carrier velocities are monitored regularly to check for signs of worn components Alarms interlock on loss of vacuum
	Continuous area (gamma) monitoring	Warn personnel of high radiation and levels in the vicinity	Identification, functional testing, battery-backed trouble alarm
High dose from sample during laboratory analyses	Airborne radiation (alpha/beta) and continuous area (gamma)	Warn personnel of high radiation and contamination levels in the vicinity	Redundancy, identification, functional testing, battery backed, trouble alarm, independent of normal instrumentation and control.
	Local monitors at sample entry pipe route into the laboratory	Detect an undiluted sample prior to dispatch to the laboratory	Fail-safe The first dispatch point in the laboratory is a shielded glovebox

2.5.11. Maintenance Facility and Solid Waste Disposal

2.5.11.1. Purpose

The purpose of a proposed Maintenance Facility is to provide a plant maintenance service for remotely removable equipment e.g., pump and ultrafilters and highly contaminated items that have been in contact with active process streams.

BNFL Inc. has an established philosophy of performing maintenance, where reasonably practicable, away from operational areas in purpose built facilities.

The primary maintenance objectives are to identify safe solutions, while adopting cost-effective policies, giving regard to minimizing secondary solid waste generation while incorporating ALARA principles.

For a number of maintainable items, it is inevitable that a degree of decontamination will be necessary to reduce activity levels, allowing workers to perform “hands-on” maintenance. Heavily contaminated equipment may require decontamination to allow the solid waste (in the form of failed components, subassemblies or complete assemblies, to be removed from their environment and disposed.

The decision to employ remotely maintainable equipment was governed by the following:

1. Expected equipment failure rates and operator occupancy during maintenance.
2. Capital costs for maintainable equipment.
3. In-situ decontaminability, operator dose uptake, and the guarantee of safe “hands on” access.
4. Failed equipment in the form of solid wastes and waste disposal strategies.

The general scope of the maintenance facility encompasses the equipment and provisions to safely receive, decontaminate, strip down, rebuild, test, and dispose of equipment items. The design life of the facility will be commensurate with that of the TWRS-P process plant.

2.5.11.1.1. Process Interaction

On failure, contaminated mechanical items where immediate “hands-on” maintenance cannot be performed, can be removed from the process within a shielded and contained transfer flask. The flask and its contents are transferred to the Maintenance Facility.

Provisions for flask maintenance and dedicated areas for the storage of new and trace active items of equipment are also proposed. Confinement and radiological safety are assured during all operations.

The facility products consist of the serviced items of equipment for reuse within the process, together with new items which can be tested in the Maintenance Facility.

Throughput consists of the items flasked to the facility for decontamination and maintenance, or preparation for disposal following remote stripdown operations.

2.5.11.1.2. Philosophy

Due to the relative complexity, and the number of small components requiring replacement comprising the maintainable equipment, coupled with BNFL's experience on maintaining similar items of equipment, it is suggested that for certain items of equipment, namely pumps, only hands-on maintenance is suitable. Decontamination is necessary to reduce activity levels to allow workers to perform hands-on maintenance. The facility will also provide services for the testing of refurbished, and new, items of equipment.

In brief, a Maintenance Facility will have provisions for the following:

1. Decontamination of recoverable and reusable parts of mechanical equipment, to a level of activity acceptable for hands-on maintenance, rebuilding and testing.

2. Servicing of items of mechanical and electrical equipment and instruments that do not require prior decontamination.

3. Preparation of items for disposal as waste. Such items may arise from the stripdown of remotely maintainable equipment.

2.5.11.1.3. Scope

The scope of equipment given here covers that which is required to:

1. Remove failed pumps from their service locations within the TWRS-P wet process.

2. Transfer failed pumps to a biological confinement and effect the removal of failed pump head diffuser/mechanical seal modules.

3. Pressure wash-down of the pump and related components.

4. Disposal of removed pump diffuser head and other components (if required).

5. Transfer of pumps having had their diffuser heads removed to a workshop facility where replacement of failed items can take place in "hands-on" conditions.

6. Removal of the refurbished pump from the workshop facility to an active service location.

7. Flask Maintenance

2.5.11.2. Description

2.5.11.2.1. Plant and Equipment

The proposed basic plant and equipment of this Maintenance Facility is indicated in Figure 2.5-16.

- A biological confinement in which to carry out wash-down and removal of the pump head diffuser. This will feature:
  - A set-down point to support a pump by its striker plate.
  - A high-pressure wash-down hose.

- Facility to post in a shielded container to receive spent pump head diffusers.
- A ram to push spent pump head diffusers into the shielded container.
- A manually operated tong unit for handling nuts and bolts.

- A Shielded Maintenance Flask and control panel similar in size and technology to those in service on the SIXEP and EARP plants at Sellafield, UK.

- A series of mobile gamma and fixed gamma gates also similar to those in service on the SIXEP and EARP plant at Sellafield. The fixed and mobile gamma gates are essentially identical, except that one is permanently fixed in position and the other is portable.

- Lifting aids to enable the movement of the flask and Gamma Gates (pump striker plates, lifting beams, etc.)

- A C3 classified workshop equipped with a lay-down frame capable of receiving pumps and transferring them between vertical and horizontal positions.

The workshop will have a bench fitted with vee-rollers on which to work on the pumps and a small lifting facility to transfer pumps between the lay-down-frame and the bench.

2.5.11.2.2. Process Description

Facilities

The Maintenance Facility is a dedicated plant where equipment can be maintained, with the proposed design based on remote stripdown to allow hands-on maintenance techniques to be employed. The main services offered being:

- Remote, partial stripdown of remotely maintainable items.
- Decontamination of remotely maintainable plant items.
- Monitoring of decontaminated plant items.
- Routing scrap plant item components to an appropriate destination.
- Completion of stripdown of components in hands-on workshops.
- Secondary local decontamination of plant item components, i.e. *hot spot* removal.
- Rebuild and testing of plant items.
- Flask maintenance work.

After decontamination, assemblies are monitored. If radiation levels are acceptable, the item is posted out and directed to the active (C3) workshops.

Operations

Remotely maintainable assemblies will be transferred to the Maintenance Facility in bottom entry flasks. The crane hoists the flask above the cave roof. The flask is then moved across the cave roof and locked in its position to the receipt gamma gate.

The gamma gate is opened, and the assembly lowered from inside the flask (by its integral winch), and on to the receipt frame within the cave.

After monitoring has shown items have been satisfactorily decontaminated, equipment is dispatched to the active workshop where hands-on maintenance is performed.

2.5.11.2.3. Maintenance Sequence

Removal of Failed Pumps from their Service Locations

Upon failure and after a wash through with a cleansing agent a pump will have its drive motor removed, holding down bolts removed and fitted with:

- An anti rotation device (rotor-lock)
- A striker plate
- A lifting pintle

A mobile gamma gate will be placed on the failed pump and the maintenance flask placed on the gamma gate. The gamma gate and flask door will be opened. (Both are driven by the gamma gate door motor.) The flask grapple is then lowered to engage on the striker plate. The pump will then be raised into the flask and the gamma gate and flask doors closed.

The flask is then transported away leaving the mobile gamma gate in the closed over the exposed penetration through the biological shielding.

Transfer of Pump to Shielded Confinement

The flask is taken to a fixed gamma gate located above the shielded confinement. The gamma gate and flask door are then opened and the failed pump is lowered into the shielded confinement where the striker plate fitted to the pump will engage on a pair of supports. The grapple is the disengaged and withdrawn to the flask and the gamma gate and flask doors are closed. A water pressure washer hose is then used to wash off any remaining process residue. Washings are to be routed back to the plant process.

A hydraulic or similarly operated table will engage on the underside of the pump head diffuser and on the impeller nut. A through-wall drive will be used to unscrew the impeller nut.

A remotely operated nut-runner will unscrew the diffuser head fixing bolts from the pump stem.

The gamma gate and flask doors are then opened, the pump is re-engaged by the flask grapple and withdrawn back into the flask. The gamma gate and flask doors are then again closed and the flask removed from the gamma gate.

A hydraulic powered ram then pushes the diffuser head from the hydraulic operated table such that it falls into a shielded container, which has been posted into the confinement.
Using a pair of manually operated tongs the impeller nut and diffuser holding bolts are then also placed into the container with the diffuser head or alternatively these may be put into a separate container for recovery operations.

Transfer of Pump to Workshop

Following washdown and activity monitoring operations, the maintenance flask is placed on the gamma gate located above the C3 (hands-on) workshop. The flask gate is opened and the pump is lowered onto the lay-down frame in its vertical position and is supported by the striker plate.

The flask grapple is then withdrawn, the flask gate closed and the lay-down frame translated to the horizontal position.

Work on the pump can either take place on the lay-down frame or it can be transferred to the workbench and vee-rollers on the workbench. The fitting of a replacement diffuser head and mechanical seal can now be carried out.

<u>Removal of a Refurbished Pump to an Active Service Location</u>

A refurbished pump is located on the horizontal pump lay-down frame and translated to the vertical position.

The flask gate is opened and the grapple lowered to engage on the pump striker plate.

The pump is raised into the flask and the gate is closed.

The flask is transported to the mobile gamma gate covering the exposed penetration at the pump service location.

The gamma gate and flask door is opened and the pump lowered to into position.

The flask and gamma gate are then removed to a storage location.

The pump is the striker plate and rotor-lock are then removed from the pump. The pump is then set up in accordance with the manufacturer's instructions. And the motor replaced is ready for service.

<u>Flask Decontamination and Maintenance</u>

It is envisaged that the Maintenance Facility will have provisions to receive transfer flasks for decontamination and maintenance.

Any contamination on the outside surface of the flask may be removed by swabbing locally. Provisions will be available to perform flask maintenance operations. This area will be equipped with test weights, to enable flask winch and rope testing to be performed.

2.5.11.2.4. Workshops

The design of the workshops allows "hands-on" maintenance to be performed. If it is found that dose rates may exceed acceptable levels, provisions will allow for local "hot-spots" to be removed.

2.5.11.3. Hazardous Situations

The following hazardous situations give rise to the potential dose to plant workers:

- Loss of primary confinement through dropped loads out of cell.
- Loss of primary confinement as a result of maintenance access to radioactive plant components.
- Transfer of contamination from maintenance operations.
- Transfer of plant items into the C3 workshop without sufficient decontamination.

- Dropped loads (out-of-cell only) leading to loss of primary confinement (see Dropped Loadout of Cell Cranes).

See Figure 2.5-16, Maintenance Facility.

Figure 2.5-16. Maintenance Facility Proposed Flasking Arrangement

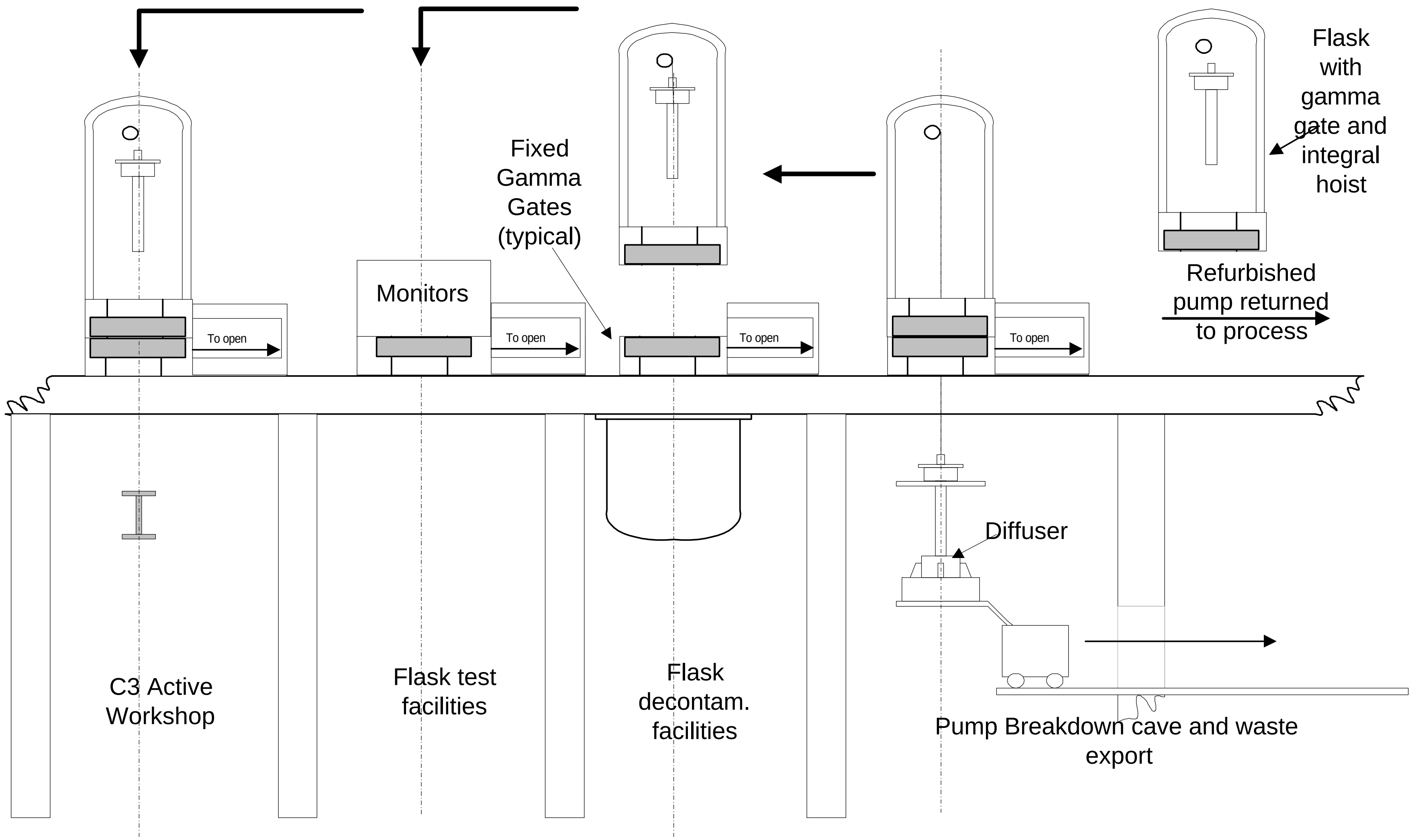


Table 2.5-11. Maintenance Facility

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Loss of primary confinement	Shielding/Confinement (Cells, Caves, Piping, Vessels, C2, C3 and C5 ventilation and Flasks). Also including gloveboxes (for through wall drives).		
Transfer of contaminated equipment exceeding those prescribed for C3 workshop	Gamma monitor on flask	Check for gross contamination on equipment removal	See gamma gate and flask under Mechanical Systems.
	Secondary decontamination	To reduce activity levels to within acceptable C3 limits	Facilitates removal of localized contamination
	Airborne radiation (alpha/beta) and continuous area (gamma) monitoring with integral alarms.	To monitor equipment contamination levels prior to entry to the C3 active workshops.	Trouble alarm diverse systems
Removal of a pump without adequate prior item decontamination within the process leading to activity levels greater than those for a C3 area after secondary decontamination	Pipework and reagent supply system	To reduce the amount of activity prior to removal To supply flush and wash liquors to the decontamination system	Monitor, which alarms on detection of excessive activity on the withdrawal of the pump. Flowmeter indicates wash liquids are delivered at the requisite rate Reagents are sampled to assure correct composition
Contamination spread from flask internal surface	Flask	Maintain confinement	Robust flask design to withstand credible drops.
	Contamination monitoring equipment	To monitor residual activity in the flask after dispatch of the contents.	Dedicated flask decontamination and monitoring facilities are provided.

Note: Maintainable equipment from LAW and HLW Vitrification processes is under review. These arisings will be considered on review completion.

2.5.12. Breathing Air System

2.5.12.1. Purpose

It is envisaged that pressurized air suits will not be required in the TWRS-P facility for maintenance or special operations. It is therefore not proposed to install a breathing air ring main. As a contingency a dedicated compressor will be situated in the balance of facility area. From this bottles can be filled and then transported to wherever required.

2.5.12.2. Description

The compressor will be specified for breathing air quality, i.e., it will be oil free, contain no components which could pollute breathing air supply. Air purity requirements will be specified.

The compressor will be sited to ensure that intake cannot entrain either fumes or particles.

The compressor will be used to fill bottles, which can then be transported to wherever required. A control panel is fitted to the bottles which in order to:

- Control air pressure
- Provide final filtration/water separation
- Provide two air outlets for each suit each with flowmeter and low flow alarm.

Use of pressurized suits would be performed under a safe system of work at the time with personnel providing back up support to people wearing the suits.

2.5.12.3. Hazardous Situations

The facility worker carrying out maintenance or special operations can be put in a hazardous situation through:

- Loss of Breathing Air either by loss of supply or rupture of line.
- Unsafe air quality

The set of Important to Safety SSCs for the above hazardous situations (or faults) is provided in the following table. The table also identifies the Safety Function and the Design Safety Features.

Table 2.5-12. Breathing Air System

Fault	Important to Safety SSC's	Safety Function	Design Safety Feature
Loss of breathing air leading to the facility worker being put in a hazardous situation	Control Panel	Air flow measurement and low flow alarm.	Multiple air outlets per suit. Stand by bottles available in situ Procedural control with no lone working. Suits provide enough air to leave work area if air supply lost (10-minute supply)
Unsafe air quality leading to the facility worker being put into a hazardous situation	Compressor/Bottles Control Panel	Provide breathable air	Compressor/bottles to meet breathing air quality standards. Compressor air in take situated in area free from fumes/ particles. Final filtration/ water separation.